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IMPROVED ION TEMPERATURE and CONCENTRATION ANALYSIS for an IMPROVED CALCULATION of HYDROGEN LOSS from VENUS

FINAL REPORT

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Purpose of the Grant

The primary purpose of the grant effort was to determine and publish the median density and temperature of H^+ as measured by the Pioneer Venus retarding potential analyzer instrument (ORPA) in one hour wide hour-angle intervals over the nightside Venus ionosphere during a solar maximum period and a solar minimum period. This information is important for calculating the present loss rate of hydrogen from the Venus atmosphere by charge exchange between H^+ and neutral O atoms. The effort is needed because previous reduction of the ORPA data was performed with the assumption that all ions had the same temperature which assumption, we now know, has lead to an over estimate of the median H^+ temperature. Also the derived parameters were occasionally in substantial error, because noise (erroneous measurements) is present in the data, which the original data reduction program was not capable of recognizing,.

Present Status

I am short of accomplishing the total goal of the proposed research effort. A sufficient number of orbits at solar maximum and solar minimum have not been analyzed using the interactive least squares program described below to define the median H^+ tmeperature and density at the desired one hour-wide-hour-angle intervals over the nightside Venus ionosphere. What has been accomplished is the development of an interactive, graphics, least-squares data reduction program and, with it, the analysis of 15 orbits whose periapses are in the bulge region. It became evident early in the grant that to adequately obtain H^+ ion temperatures independently the O^+ ion temperatures and to remove erroneous analyses, it would be necessary to visually analyze individual sweeps. With the assistance of an undergraduate programmer, the computer program previously used to reduce ORPA data has been modified to least-squares-fit the measured ORPA current differences with an algorithm that permits H^+ to have a different temperature than that of $O^+$and other ions. The program also derives the density of H^+ and other major ions. The program was modified to permit the least-squares-fitting of individual sweeps to be performed interactively. Interactive analysis of individual sweeps has permitted us to view the measured current differences (or currents), remove bad current difference values, modify the relative composition of minor ions to improve the fit, and make more intelligent decision as to when the fitting process is satisfactory. I have found that this process of individual sweep analysis greatly increases the accuracy of the derived H^+ temperatures and densities and other physical parameters obtained from the fit and is essential for the accomplishment of the overall grant effort. With the use of this program, the ORPA data for 15 orbits whose periapses fall in the hydrogen bulge region have been reduced. These 15 orbits are the beginning of the effort to reduce all the nightside data so that median values of the H^+ temperature and density as a function of altitude and hour-angle over the night side ionosphere at solar maximum conditions could be determined. I intend to complete the goal of this grant without further NASA funds.

A paper "Lack of thermal equilibrium between H^+ and O^+ temperatures in the Venus nightside ionosphere: observation and theory" authored by William C Knudsen and Andrew F. Nagy was presented at the Venus II - Geology, Geophysics, Atmosphere, and Solar Wind Environment international meeting held at Tucson, Arizona Jan. 4-7, 1995. In this paper was presented ORPA measurements establishing a difference of a much as 2000^{o} K in the temperatures of H^+ and O^+ in the hydrogen bulge region at altitudes over 325 Km. Initial numerical modeling efforts to reproduce the measurements and to come to an understanding of the processes responsible for the temperature difference was also presented. This material has been prepared for submission to the Journal of Geophysical Research.

As part of this grant effort, I have also contributed data and analysis to the preparation of several other presentations and preprints for publication directly related to the maintenance of the nightside Venus ionosphere and loss of ions therefrom. Presentations at the Venus II International Meeting held at Tucson include:

"The Dynamics of the Nightside Ionosphere of Venus: Analysis of PVO Plasma Measurements"
D. S. Intriligator, L. H. Brace, J. M. Grebowsky, R. E. Hartle, W. T. Kasprzak and W. C. Knudsen

"Measurement of Suprathermal Electron Density and Temperature in the Magnetosheath of Venus"
T. N. Knudson, K. L. Miller and W. C. Knudsen

"Suprathermal Electrons Fluxes in the Venus Nightside Ionosphere at Moderate and High Solar Activity",
K. Spenner, W. C. Knudsen and W. Lotze

Preprints submitted, or to be submitted for publication,. include:

"Suprathermal Electron Fluxes in the Venus Nightside Ionosphere at Moderate and High Solar Activity".
K Spenner, W. C. Knudsen and W. Lotze, to be submitted to the *J. geophys. Res.*

"Observations of Ionospheric Escape on Venus Night Side", J. D. Mihalov, C. T. Russell, W. T. Kasprzak, W. C. Knudsen, Submitted to the *J. Geophys. Res.*, 1995.

"Ion Density, Temperature, and Composition of the Venus Nightside Ionosphere during a Period of Moderate Solar Activity: Implications for Maintaining the Central Nightside", K. Spenner, W. C. Knudsen and W. Lotze, submitted to *J.Geophys.Res.*, 1995.